AD-A118 927 TELEDYNE GEOTECH ALEXANDRIA VA SEISMIC DATA ANALYSIS--ETC F/G 9/2
SDAC FINAL REPORT, 1 OCTOBER 1979-30 SEPTEMBER 1980.(U)
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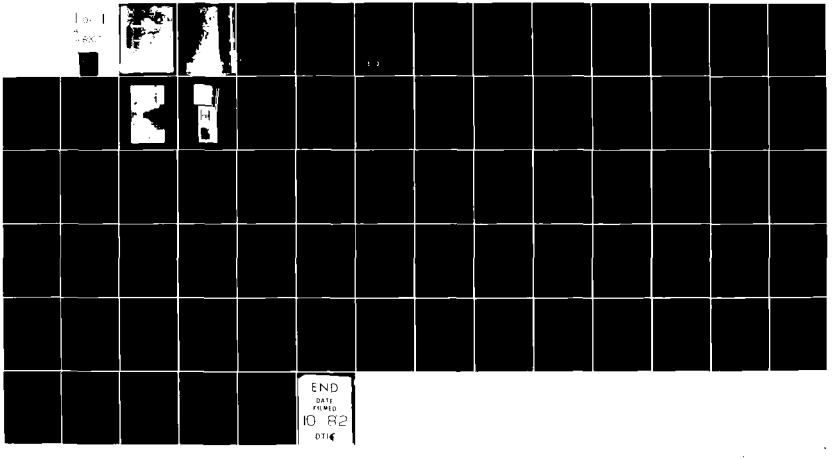

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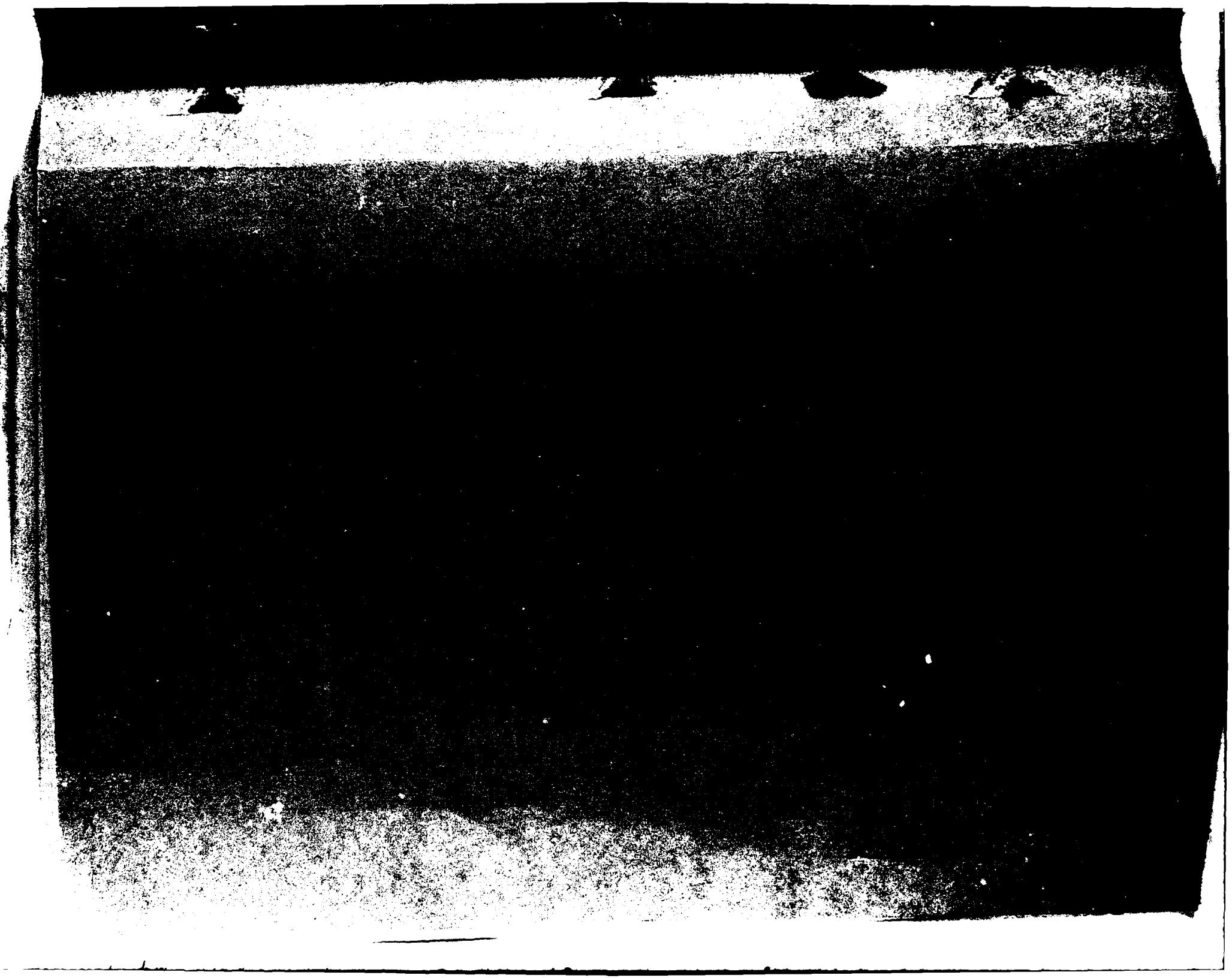

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The effort required to operate and maintain the Seismic Data Analysis Center for the contract period beginning 1 October 1979 and ending 30 September 1980 is summarized in this report. Statistics on the use of the computer systems and the seismic data received, stored and maintained at the center are also tabulated. Tasks performed under this contract included the operation of digital computers and analog systems, the programming to maintain the digital computers, the maintenance of the systems, and the services provided to those participating in the VELA project.

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SDAC FINAL REPORT

SEISMIC DATA ANALYSIS CENTER REPORT NO.: SDAC-TR-80-8

| | |
|---|---|
| AFTAC Project Authorization No.: | VELA T/0706/B/PMP |
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## ABSTRACT

The effort required to operate and maintain the Seismic Data Analysis Center for the contract period beginning 1 October 1979 and ending 30 September 1980 is summarized in this report. Statistics on the use of the computer systems and the seismmic data received, stored, and maintained at the center are also tabulated. Tasks performed under this contract included the operation of digital computers and analog systems, the programming to maintain the digital computers, the maintenance of the systems, and the services provided to those participating in the VELA project.

The acquisition of a VAX 11/780 computer system to develop algorithms for detecting signals and local events at regional distances is also discussed. Improvements to the automatic association program, the intelligent line interfaces, the on-line detector, and the manual digitizing process were made during the contract period and are described in this report.

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# INTRODUCTION

This report summarizes the work performed to operate, program and maintain the computer systems at the Seismic Data Analysis Center during the contract year which began on 1 October 1979 and ended on 30 September 1980. Also included is a summary of the data services provided to government agencies, contractors, and others conducting seismic research related to the VELA projects. The results of the effort to improve and support the hardware and software systems which record, process, analyze, and store the seismic data from the VELA twork are presented as well.

## Summary of Activities

Three major systems were shut off during the contract period. They were the Seismic Input Processor, which supported the continuous data flow to the DATACOMPUTER, the IBM 360/40A that was used for many years as the Detection Processing System, and the PDP-15/50 Interactive Processor. This action had a major impact on the routine operation of the systems and on the programming staff. Processing functions were moved to different computer systems and operators had to adapt to the changes and learn new procedures. Program maintenance also increased, because of the hardware reconfiguration.

The installation of new equipment and the dismantling and removal of older systems required exceptional maintenance effort. These activities took place while routine maintenance continued on the peripherals and other computer systems.

Data services continued its support of other agencies contributing research efforts to the VELA project. One of the major data sets that was developed consisted of SRO data from selected events occurring during the period from 1976 to 1982.

A major system was procured in order to accomplish the data management research task. It was a VAX-11/780, configured with a special high speed graphics device, to facilitate investigating data obtained from seismic events occurring at regional distances. The VAX system will also provide the processing capability for conducting detection experiments.

The accuracy of the program to automatically correlate signal arrivals into events was improved; this resulted in a reduction of false events being created and an increase in the number of valid events which were previously missed.

The detector for the on-line data stream was successfully implemented on the PDP-11/70. Thus the on-line system is only required to record data and print NORSAR detections. The data recording is accomplished in a partition of the IBM 360/40 system used for the Network Event Processor; consequently the 360/40A that was performing as the Detection Processing System could be declared in excess.

The configuration of the Communication and Control Processor that receives the real-time data was altered. An Intelligent Line Interfaces (ILI) was added to accept data from the Wyoming site.

Several other tasks were added to the contract. These tasks include projects to move the digitizer from the IBM 360/44 to the DEC PDP-11/70, to upgrade the bus structure of the Communication Control Processor, to implement hardware that will route the real time data stream of NORSAR data to the USGS in Colorado, and to obtain an analog tape unit and a PDP-11/40 system for converting analog data to digital form.

Facility Overview

As noted, major changes were made to the computer systems and the way the real-time data were processed. The equipment in the facility was moved, in order to install the new VAX computer system. The wall that separated the IBM 360/44 from the other equipment was removed to allow better air-conditioning and equipment surveillance. At the conclusion of the contract, the major systems consisted of an IBM 360/44, an IBM 360/40, the Communication and Control Processor (CCP), a DEC PDP-11/70, and a DEC VAX 11/780.

Figure 1 is a view of the computer room showing the current arrangement of the equipment. The VAX was configured with two alphanumeric color terminals and a high speed vector graphics CRT for the development of the Regional Event Location Project. This equipment is shown in Figure 2. When the 360/40A was placed in excess, the detection function it was providing was moved to the PDP-11/70. The data recording function it served was moved to a foreground memory partition of the IBM 360/40. Transmission of data to the Mass Store at Computer Corporation of America (CCA) was terminated. The current configuration for handling the data at SDAC is shown in Figure 3. The total amount

of data and different files sent to the Mass Store during its operation is shown in Figure 4.

Figure 1. - View of the SDAC Computer Facility

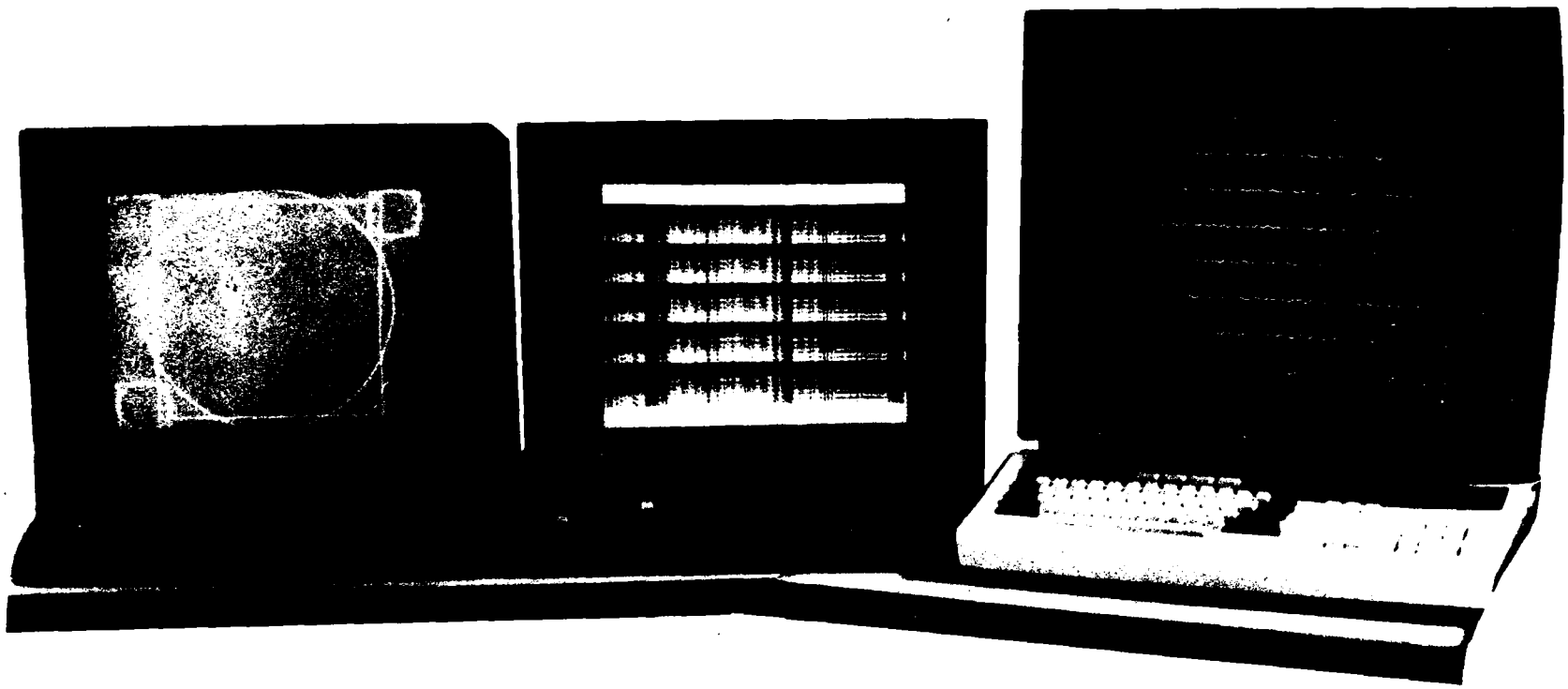

Figure 2. - Upgraded Graphics System

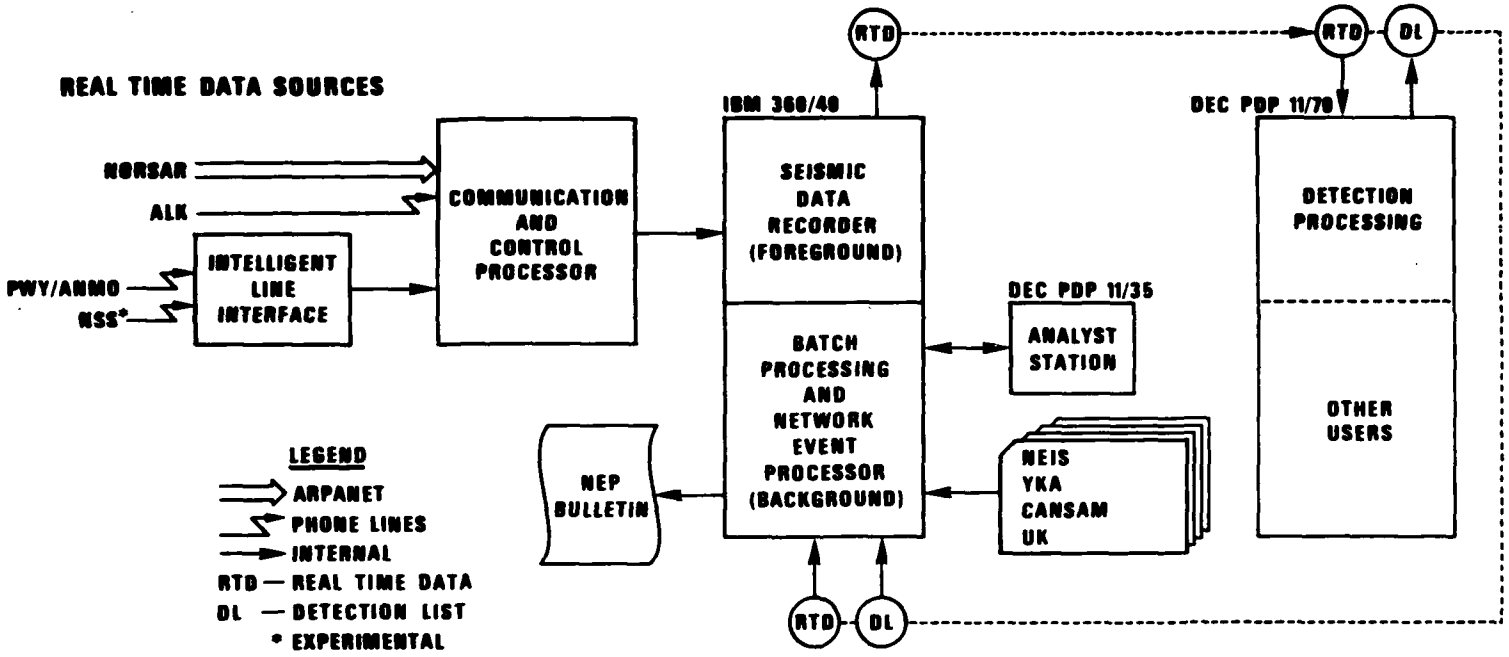


Figure 3. - Real-Time Data Flow

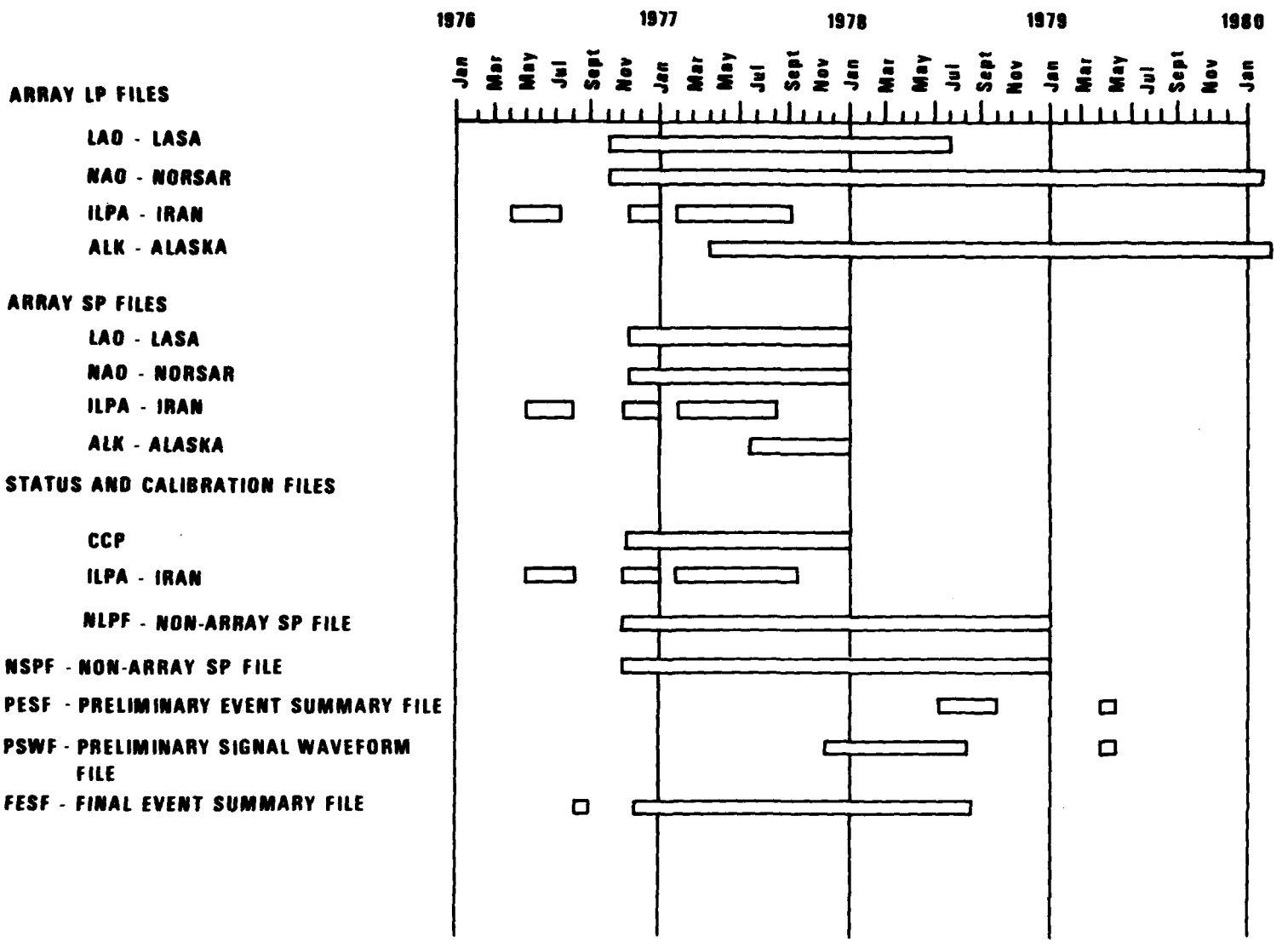


Figure 4. - Mass Store Data

## Organization

The information in the following chapters is presented in the same order as the tasks are presented in the contract. Major task numbers are provided to facilitate references to the contract. Chapter 2 describes the operation of the equipment and contains operational statistics. Chapter 3 summarizes the programming effort of the operational systems; Chapter 4 is a description of the maintenance effort. Chapter 5 goes into considerable detail about the activities of data services. The development of the data management system is presented in Chapter 6. The tasks to move the digitizer, change the bus structure on the CCP, provide NORSAR data to the USGS, and develop an A/D system on the PDP-11/40 are described in Chapter 7. Finally, the manuals which were updated and other major documentation accomplished for the contract is summarized in Chapter 8.

## Authority

This work was performed for the VELA Seismological Center under Air Force Contract F33600-79-C-0549, project VT/0706/B/AFLC. This report is written to comply with the requirements of data item 011A2 in the contracts data requirements list.

## OPERATIONS (Task 4.1)

The computer equipment at the SDAC consists of batch, interactive, and communication processors. The Communication and Control Processor (CCP) is a dedicated system requiring hourly checks to insure the integrity of the real-time data. One of the IBM 360/40's, referred to as the 40A, operated for the first eight months of the contract as a dedicated system, requiring periodic tape changes and continuous monitoring to insure data recording. The other IBM 360/40 system, the 40B, is used interactively by the seismic analyst to review and correlate the real-time data. For the first part of the contract, this data was recorded on the 40B itself in a foreground partition. The 40B is also used as a batch processor to support the analyst and other users as time permits. The DEC PDP-11/70 is an interactive system and requires little support from the operators. It is, however, used for plotting and for signal detection, both of which are under operation control. Finally the IBM 360/44 is operated as a batch module, with the jobs being submitted by researchers using remote terminals throughout the facility.

Terminating the data transfers to the Mass Store, placing the IBM 360/40A in excess, and altering the procedures of doing the detection/recording function caused considerable changes in the operational procedures at the SDAC.

Several types of files were routinely repared by operations to send to the Mass Store location in Boston, Massachusetts. Some of these were the real-time data files, which consisted of the continuous short and

long period data. These data were input to the CCP, formatted and sent to the Mass Store without operation intervention, but with operator monitoring. The other files consisted of the Preliminary and Final Event Summary P(F)ESF files and the Preliminary Signal Waveform File (PSWF). These files were created by operations afer the seismic analyst had reviewed the data and determined the locations of the events for a given day. The P(F)ESF were composed of alphanumeric information which was created by reformatting the data resulting from the seismic analysis. Each of these files could be created and sent to CCA without much use of computer time, but significant effort was required to maintain logs and to verify the correctness of the transfer. The major problem was the availability of the computer at the mass store. Re-runs were frequent and records were constantly being reviewed to insure data integrity.

Creating and transmitting the PSWF was quite different, in that each run took from four to six hours of processing time on the 360/40B. The transfers to the Mass Store, with the noted availability problems, would average about an hour. The recordkeeping associated with this transfer was also significant.

When these transfers were no longer required, a significant amount of computer and personnel resources became available.

The acquisition of a VAX 11/780 to support the development of the data management system also required considerable changes to the operational conditions and physical arrangement of the systems at the SDAC. After careful review of air-conditioning requirements, power needs, and

available floor space, it was decided that the IBM 360/40A system, used as the detector and recorder of the real-time data for some 15 years, should be placed in excess and removed from the computer room. its absence provided the power, air-conditioning, and floor space to accommodate the new equipment.

The detector function had already been moved to the PDP-11/70 during the previous contract because of erroneous results produced by the IBM 360/40A. The recording function does not require extensive processor resources; consequently, it was implemented in a foreground partition of the IBM 360/40B and, as a backup, implemented on the IBM 360/44. This required operations to run the detection processing on the 11/70 and maintain the associated records.

The operation of the CCP, NEP (IBM 360/40), and the IBM 360/44 remained about the same as in previous years. The major concern was the continuing failure of the aging air-conditioners throughout the particularly hot summer of 1980. In order to protect the equipment, major systems were shut off at the expense of the research requirement for processing time.

Operational statistics for the computer systems, for the duration of the contract year, are provided in the following tables. Table I shows the utilization of the CCP. This system operated correctly over 98 percent of the time. A percentage in excess of 99 would have been obtained, except for the testing required to integrate the Intelligent Line Interfaces, the data lines from NORSAR to the USGS, and install a redundant bus structure. Tables IIa and IIb show the total data

recorded during the contract period. After the 360/40A was removed from the facility, the mandatory recording time was eight hours per day. During the four months the system was operated in this mode, a total of 8.3 hours of data was lost. The primary cause of this data loss was power failure. Table II summarizes the utilization of the 360/40B for tasks other than the recording function. Tables IV through VI show the usage of the 360/40 in block time for the TS operating system, block time for all of the operating systems, and usage by ENSCO respectively. Finally, Table VII provides usage statistics for the PDP 11/70. The table shows log-on time for the various tasks, rather than the time the job was in the machine; this accounts for the high figures.

**Table I. - CCP Downtimes in Hours**

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Systems Crashes | .5 | .4 | .1 | .5 | 1.1 | 3.6 | 1.1 | 2.1 | 3.5 | 2.9 | .4 | .9 | 17.1 |
| System Testing | .5 | .8 | - | - | 5.6 | 6.2 | 2.1 | - | 31.4 | 22.4 | 1.7 | - | 70.7 |
| Investigating | .1 | .4 | - | .1 | .1 | .2 | .1 | .1 | .2 | - | - | .1 | 1.4 |
| P/M | .7 | - | - | 1.0 | - | 13.6 | - | - | 1.0 | 2.6 | 52.0 | - | 70.9 |
| Operations | - | .2 | - | 1.7 | 2.1 | .1 | - | - | - | 1.0 | - | .1 | 5.2 |
| Power Failure | - | - | - | - | - | - | 1.1 | - | 1.0 | - | - | - | 2.1 |
| Total Downtime | 1.8 | 1.8 | 0.1 | 3.3 | 8.9 | 23.7 | 4.4 | 2.2 | 37.1 | 28.9 | 54.1 | 1.1 | 167.4 |
| Total Possible Recording Hours | 744 | 720 | 744 | 744 | 696 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 8784 |
| Total Hours of Recording | 742.2 | 718.2 | 743.9 | 740.7 | 687.1 | 720.3 | 715.6 | 741.8 | 682.9 | 715.1 | 689.9 | 718.9 | 8616.6 |
| Total % Recording Experience | 99 | 99 | 99 | 99 | 98 | 97 | 99 | 99 | 95 | 96 | 92 | 99 | 98.1 |

## Table IIa. - DPS Downtime in Hours

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardware Failures | .7 | 1.1 | 2.6 | 1.6 | 5.3 | - | .3 | .7 | - | - | - | - | 12.3 |
| Power Failures | .2 | .2 | 1.1 | .2 | 1.1 | - | 1.1 | .1 | - | - | - | - | 4.0 |
| System Crashes | 3.6 | 2.1 | 1.1 | .7 | .8 | 1.1 | 1.1 | .4 | - | - | - | - | 10.9 |
| P/M | 3.6 | - | 2.3 | 4.8 | 3.8 | 6.4 | 3.5 | - | - | - | - | - | 24.4 |
| Testing | .3 | - | - | - | - | - | - | 39.4 | - | - | - | - | 39.7 |
| Operation Failure | - | - | .5 | .1 | .1 | - | .1 | - | - | - | - | - | .8 |
| Investigating | - | - | - | - | .4 | - | - | - | - | - | - | - | .4 |
| Removal of the 360/40A | - | - | - | - | - | - | - | 12.6 | - | - | - | - | 12.6 |
| Total Downtime | 8.4 | 3.4 | 7.6 | 7.4 | 11.5 | 7.5 | 6.1 | 53.2 | - | - | - | - | 105.1 |
| Total Possible Recording Hours | 744 | 720 | 744 | 744 | 696 | 744 | 720 | 744 | - | - | - | - | 5856 |
| Total Hours | 735.6 | 716.6 | 736.4 | 736.6 | 684.5 | 736.5 | 713.9 | 690.8 | - | - | - | - | 5750.9 |
| % Recording | 99 | 99 | 99 | 99 | 98 | 99 | 99 | 93 | - | - | - | - | 98.3 |

Table IIb. - Seismic Data Recorder Statistics In Hours

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Power Failures | - | - | - | - | - | - | - | - | 2.5 | 2.5 | .2 | .6 |
| Hardware Failures | - | - | - | - | - | - | - | - | .1 | .2 | - | 1.1 |
| Operations | - | - | - | - | - | - | - | - | .2 | - | - | - |
| System Crashes | - | - | - | - | - | - | - | - | - | - | - | .9 |
| Total Downtime During Mandatory Recording Hours | - | - | - | - | - | - | - | - | 2.8 | 2.7 | .2 | 2.6 |
| Scheduled Recording Hours (Available) | - | - | - | - | - | - | - | - | 240.0 | 248.0 | 248.0 | 240.0 |
| Actual Hours Recording During Scheduled Time | - | - | - | - | - | - | - | - | 237.2 | 245.3 | 247.8 | 237.4 |
| Total Recording Hours | - | - | - | - | - | - | - | - | 391.5 | 417.0 | 428.9 | 384.9 |

## Table III. - 40B Utilization In Hours

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL | % UTILIZATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Classified | - | - | - | - | - | - | - | - | - | - | 81.0 | 125.6 | 206.6 | 2 |
| NEP | 184.0 | 173.0 | 204.0 | 198.0 | 189.0 | 191.0 | 223.0 | 197.0 | 166.0 | 233.5 | 136.9 | 113.1 | 2208.5 | 25 |
| Real-Time Programming | 374.0 | 211.0 | 146.0 | 112.0 | 55.0 | 23.0 | 37.0 | 23.0 | 78.5 | - | - | - | 1059.5 | 12 |
| Documentation | 1.0 | 3.5 | 3.0 | 4.5 | 6.5 | 3.0 | 2.5 | 14.5 | 9.5 | 4.5 | 5.0 | 8.0 | 66.0 | - |
| Operations | 17.0 | 4.0 | 4.5 | 15.0 | 23.0 | 14.0 | 18.5 | 26.5 | 5.0 | 1.0 | 2.5 | 6.0 | 137.0 | 1 |
| Batch Programming | 4.5 | .5 | - | - | - | - | - | - | - | - | - | - | 5.0 | - |
| DP Testing | - | - | - | - | - | - | - | 28.0 | - | 45.5 | 61.5 | 62.7 | 197.7 | 2 |
| On-Line Recording | - | - | - | - | - | - | - | - | 391.5 | 417.0 | 428.9 | 384.9 | 1622.3 | 18 |
| AA | - | - | - | - | - | - | - | - | - | 2.5 | 7.5 | 1.5 | 11.5 | - |
| Data Services | - | - | - | - | - | - | - | - | - | - | 1.0 | - | 1.0 | - |
| Downtime | 14.5 | 6.5 | 9.0 | 59.5 | 36.0 | 51.0 | 42.5 | 180.0 | 65.0 | 40.0 | 19.7 | 17.7 | 541.4 | 6 |
| Idle | 149.0 | 321.5 | 377.5 | 355.0 | 386.5 | 462.0 | 396.5 | 275.0 | 4.5 | - | - | - | 2727.5 | 31 |
| Total Available Hours | 744 | 720 | 744 | 744 | 696 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 8784.0 | |

## Table IV. - Distribution of 360/44 Block Time of TS44 (In Runs)

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL | % OF TOTAL RUNS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data Services | 1731 | 1330 | 1564 | 1930 | 2350 | 1799 | 1948 | 2830 | 2133 | 1602 | 1408 | 2364 | 22989 | 42 |
| Systems | 1560 | 1741 | 1212 | 947 | 907 | 814 | 713 | 622 | 759 | 924 | 921 | 728 | 11848 | 22 |
| Operations | 192 | 233 | 231 | 218 | 196 | 311 | 215 | 225 | 250 | 256 | 241 | 201 | 2769 | 5 |
| Real-Time | 47 | 40 | 59 | 37 | 57 | - | - | - | - | - | - | - | 240 | - |
| Batch Programming | 413 | 270 | 163 | 192 | 287 | 146 | 271 | 104 | 219 | 295 | 151 | 230 | 2741 | 5 |
| Detection Processor | - | - | - | - | - | 134 | 182 | 233 | 240 | 187 | 51 | 23 | 1050 | 2 |
| ENSCO | 296 | 91 | 156 | 219 | 184 | 544 | 271 | 18 | - | 1 | - | 10 | 1790 | 3 |
| SDCS | 208 | 232 | 227 | 329 | - | - | - | - | - | - | - | - | 996 | 2 |
| VSC | 139 | 51 | 69 | 38 | 56 | 20 | 16 | 6 | 5 | 36 | 5 | 27 | 468 | 1 |
| Research | 732 | 695 | 433 | 730 | 970 | 948 | 704 | 635 | 687 | 686 | 553 | 815 | 8588 | 16 |
| NSS Evaluation | 143 | 85 | 120 | 167 | - | - | - | - | - | - | - | - | 515 | 1 |
| AFOSR | 9 | 19 | 38 | 29 | - | - | - | - | - | - | - | - | 95 | - |
| Documentation | 5 | 11 | - | - | - | - | - | - | - | - | - | - | 16 | - |
| TOTAL RUNS | 5475 | 4798 | 4272 | 4836 | 5007 | 4716 | 4320 | 4673 | 4293 | 3987 | 3330 | 4398 | 54105 | |

## Table V. - Distribution of 360/44 Block Time (In Hours)

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL HOURS | % OF TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOS | 15.5 | 7.0 | 12.0 | 25.5 | 11.5 | 7.5 | 8.5 | 11.5 | 16.5 | 17.5 | 19.5 | 14.5 | 167.0 | 2 |
| Classified | 32.5 | 25.0 | 34.0 | 32.5 | 9.0 | 17.0 | 10.5 | 2.5 | 18.0 | 14.0 | 21.0 | 4.5 | 220.5 | 3 |
| PSWF Data Transfer | 10.0 | 2.0 | - | - | - | - | - | - | - | - | - | - | 12.0 | - |
| TS44 | 645.5 | 637.0 | 671.5 | 632.5 | 628.0 | 658.0 | 662.5 | 677.0 | 573.0 | 636.0 | 345.5 | 587.0 | 7353.5 | 83 |
| DP/NEP Test | - | - | - | - | - | - | - | 13.5 | - | .5 | - | - | 14.0 | - |
| On-Line Recorder | - | - | - | - | - | - | - | - | - | 5.0 | 2.5 | - | 7.5 | - |
| AA | - | - | - | - | - | - | - | - | - | 10.5 | 107.5 | 78.5 | 196.5 | 2 |
| NEP Classified | - | - | - | - | - | - | - | - | - | - | 126.5 | - | 126.5 | 1 |
| Downtime | 40.5 | 49.0 | 26.5 | 53.5 | 47.5 | 61.5 | 38.5 | 39.5 | 112.5 | 60.5 | 121.5 | 35.5 | 686.5 | 8 |
| TOTAL HRS. OPERATING | 703.5 | 671.0 | 717.5 | 690.5 | 648.5 | 682.5 | 681.5 | 704.5 | 607.5 | 683.5 | 622.5 | 684.5 | 8097.5 | |
| % OF TOTAL HRS. AVAILABLE MONTHLY | 94 | 93 | 96 | 93 | 93 | 92 | 95 | 95 | 84 | 92 | 84 | 95 | | |

Table VI. - ENSCO TS44 Utilization in Percent

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | AVERAGES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wall Clock (Total) | 8 | 1 | 1 | 3 | 3 | 13 | 14 | - | - | - | - | - | 6 |
| CPU Time (Total) | 12 | 1 | 1 | 2 | 4 | 15 | 18 | - | - | - | - | - | 7 |
| CPU Time (Mon-Fri) | 9 | 1 | 1 | 2 | 3 | 15 | 16 | - | - | - | - | - | 7 |
| Wall Clock (Mon-Fri, 8-5) | 7 | 2 | 3 | 5 | 7 | 21 | 19 | - | - | - | - | - | 9 |
| Job Submittals | 5 | 2 | 3 | 4 | 3 | 9 | 6 | - | - | - | - | - | 4 |

## Table VII. - PDP-11/70 Usage in Hours

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDAC General | 98.6 | 213.4 | 167.4 | 287.3 | 311.1 | 220.4 | - | - | - | - | - | 2.2 | 1300.4 |
| SDAC Research | 158.1 | 262.0 | 156.0 | 156.4 | 214.5 | 199.5 | - | - | - | - | 22.9 | 2.6 | 1172.0 |
| SDAC Sys Prog. | 341.2 | 278.0 | 269.5 | 448.4 | 395.1 | 591.1 | - | - | - | - | 65.0 | 45.5 | 2433.8 |
| Real-Time Prog. | 416.4 | 491.0 | 395.8 | 625.2 | 561.6 | 310.5 | - | - | - | - | 63.6 | 22.2 | 2886.3 |
| Operations | 87.0 | 164.0 | 167.8 | 246.7 | 276.2 | 581.5 | - | - | - | - | 153.1 | 191.5 | 1867.8 |
| VSC | .1 | 8.7 | 34.0 | 61.7 | 10.0 | 32.1 | - | - | - | - | 5.1 | 2.8 | 154.5 |
| ENSCO | 12.5 | 1.1 | - | - | 7.3 | - | - | - | - | - | - | - | 20.9 |
| Documentation | - | 10.1 | 65.3 | 45.4 | - | - | - | - | - | - | 24.4 | 16.4 | 161.5 |
| Micro Design Submittal | - | 80.7 | - | - | - | - | - | - | - | - | - | - | 80.7 |
| Maintenance | - | - | - | - | - | - | - | - | - | - | 1.9 | - | 1.9 |
| Data Services | - | - | - | - | - | - | - | - | - | - | 1.1 | 2.9 | 4.0 |
| | | | | | | | | | | | | | 10083.8 |

*Statistics for the April - July were lost due to problems with the accounting file.

## PROGRAMMING (Task 4.2)

Most of the programming effort consisted of maintaining and improving the operational systems. One new program was developed to record the real-time data in a foreground partition of the 360/40 used for the Network Event Processor (NEP). This capability was implemented when the signal detection function was moved to the PDP-11/70. As a result, the 360/40 used as the Detection Processing System and recorder was declared in excess, enabling the installation of new equipment without adding additional floor space, power, and air-conditioning.

Numerous changes were made to the on-line systems, in addition to the new recording program. The Communications and Control Processor (CCP) was modified to support changes in the data configuration and to support other development effort. On 2 January 1980, a CCP version which terminated transmission of data to the SIP was implemented.

### CCP

A development version of the CCP was created which includes the following:

- the Analog Waveform Interface (AWI)/USGS Data Link and the PWY/ILI first-level code implementation,
- the removal of code and variables associated with N01 (National Seismic Station Prototype) and the SIP (Mass Store),
- the removal of N01 traces from the default display,

- a new configuration module and some device tables, and
- a modification to the hourly status display format to handle the USGS device.

This development version of the CCP has been running for several months with only one major problem. The CCP claimed to be flushing output messages to the AWI because of a device-not-ready condition. The problem was solved by increasing the BAUD rate over the physical interface.

Other system work to support the CCP included:

- a utility process to provide easier interpretation of CCP traps; it consists of two programs, one that queries the data file, and one that enters the data,
- a manual to assist in training programmers to use the CCP and to limit debugging time on the system, and
- a set of operational procedures to aid the operations staff in locating and correcting problems in the operation of the CCP.

Detection Processing System

The on-line Detection Processing System (DPS) was found to contain software errors that caused very large and very small signals to go undetected and signals with large S/N ratios to be "detected" falsely. These failures have adversely affected the performance of Automatic

Association and the NEP Bulletin throughout their history. Attempts to find and correct the errors failed. A new DP was written as a logical FORTRAN copy of the existing machine-language-microcode system. The system resides on the PDP-11/70. It reads DP tapes and produces an output detection stream. The details concerning this reconfiguration are reported in Chapter VI, entitled Data Management.

NEP

As previously noted, the recording function of the DPS was moved to the 360/40 which performs the NEP function. The new recording system creates output tapes in precisely the same format as did the DPS. NORSAR detections are logged on the printer and written to tape as before; in addition, the NORSAR EPX data are also logged on the printer. Significant improvements were made to the format of the detections listed on the printer. Latitudes, longitudes, and origin times, arrival times, azimuths and velocities are shown, rather than just azimuths and velocities and arrival times. The recorded tapes are quality control checked on the 360/44, then taken to the PDP-11/70 for the detection processing function. The output from the 11/70 is in the format expected by the DELOG program. Having the data in the DELOG form allows regular processing by NEP.

For the NEP system, the design of the LP beaming and rotation algorithms and the necessary interchanges between the PDP-11/35 and the IBM 360/40 were completed. Travel time errors were found to be excessive for the wave paths of long-period Rayleigh and Love waves along continental margins. Computations were substantially improved by using one degree increments of the travel path rather than two degree increments.

In addition, a land/water grid with one degree (rather than five degrees) spacing was constructed and coded into an array in the LP surface wave travel time routine SURFTT. The result was a much more accurate estimation of the travel times, especially at periods of 20 seconds. Shorter velocity arrays were also added to the SURFTT routine to correct for surface wave dispersion at longer periods.

A number of programs were written and/or revised during the contract period.

- A program ESAR was written to consolidate the output tapes created by the Mass Store process.
- A program MSAC was created to compare Mass Store tapes.
- A program PHAZID was revised to separate possible arrivals on long-period rotated radial traces from those on other long-period traces.
- The subroutine NSBLTN in program NEISBLTN was revised to accommodate data from cards punched from formatted tapes.
- NEISBLTN was revised to eliminate program terminations and dumps caused by incorrect input cards.
- Program NEISBLTN and NEISSTOPQ were revised to reject arrivals outside a time interval as specified by input cards, thus reducing run time.
- Data sets residing on the 2311's disk files were moved to the 2314's and all 2311 disk drives were placed in excess.

DEC PDP-11/70

A major event occurring on the DEC 11/70 during the contract period was the change from Version Six to Version Seven of the UNIX operating system. This change was made for many reasons. The Version Six system was hopelessly convoluted; it contained multiple copies of the same programs, and matching binary or executable code to the corresponding source code was difficult. Version Seven contained FORTRAN 77, which produced C language intermediate code, rather than the native MACRO assembly language produced by Version Six. USGS is also running Version Seven, so that compatibility could be maintained with their systems and development. The new version also provided a clean kernal and a fresh file system, both missing in the Version Six system; our Version Six system was obtained from another facility, and contained their local modifications. Version Seven still required considerable support. Routines running on Version Six had to be converted to Version Seven, while the normal support for the system and users was kept current. The following activities relating to the support of the UNIX operating system took place during the contract period:

- a spooler for the NECwriter output device was designed, and installed for general use,
- two more terminal interfaces were installed on version seven UNIX, allowing direct access of 32 ports,
- an ADM42 terminal was incorporated into the system to take advantage of its special word processing functions,
- the plotter was installed to plot TS44 tapes,

- the plotter package for version seven had a problem with data buffering; corrections involved modifications to the I/O sequence,
- the new tape driver was installed,
- the following device drivers were corrected for use in Version Seven:
  - the DZ terminal multiplexor,
  - the RP04 88MB disk driver,
  - the LP printer module, and
  - the Systems Industries disk driver,
- the ARPANET software was installed on Version Seven of UNIX,
- a new driver for the RP04 disk now allows direct loading of the operating system from any file system on the disk,
- a file system was reconfigured to permit program root segments to reside on the RP0 device,
- a new Version Seven file structure was constructed which uses both the RP04 and the SI 300 MB disk,
- backup procedures for all file systems were released to operations,
- the DCHECK command was modified to exclude file systems larger than 40,000 files, in order to reduce execution time,
- a bug was corrected in the system DUMP command in which errors were indicated when file size calculations disagreed,

- a new command CHOWNALL to facilitate the manipulation of owner and group access bits on all files in a given tree structure was implemented to aid in the transfer of files from Version Six UNIX to Version Seven,

- the priority specified in the terminal flush routine was changed to conform to the priority used by the terminal driver,

- the WRITE command was modified to transmit by character rather than by line so that the receiving terminal can see the line as it is being typed,

- the WALL command was modified to identify the sender of the message,

- the "c shell" and "ex" editor were installed, and

- the University of British Columbia FORTRAN 77 compiler was converted to Version Seven UNIX with major modifications to the I/O software.

Performance measuring software was installed in the UNIX operating system. Associated programs that exercise these modifications have indicated the need for a new process scheduling algorithm and a new swapping algorithm. Both changes were made and an improvement to the system response was noted.

Support was provided to programs and systems used by the researchers, analysts, and data services. This support consisted of:

- creating the graphic library with source code from Lincoln Laboratories,
- install the USGS graphics software,
- converting the program that writes subset tapes from the waveform data base from Version Six to Version Seven UNIX,
- testing programs that read and write SUBSET tapes,
- correcting a problem in the file header of the program that creates a SUBSET tape from the waveform data base,
- implement user selection of the magnetic tape drive,
- installing a program to allow FORTRAN 77 users to write unformatted tapes, and
- developing a HEX/ASCII dump routine to correct a data services problem with reading SRO day tapes.

Interactive Processor DEC PDP-15/50

The interactive processor, the PDP-15/50, was declared in excess during the contract period. The only programming effort placed on this system was to insure that copies were made of source programs which may prove useful on other systems.

Batch Processor IBM 360/44

The last system to be discussed is the 360/44. Most of the programming effort went to support data services. The remainder of this chapter gives a brief description of the programs that were modified and

the function they serve. A summary of the cataloging activity is also provided.

- Program NEWPLOT, which is used to plot SUBSET tapes, was modified to include fractions of seconds in the header information, to increase the skip capability, and to handle large seismogram numbers.

- Program SROPLOT, which is used to plot SRO tapes, was changed to correct erroneous time codes, demultiplexing errors, and to simplify the plot format.

- A program DUPCHK was written to verify the output of the SRO day tape duplication program

- The program which subsets SRO day tapes is now able to subset all the SP detections contained on a tape.

- Program SRODUP was revised to handle up to five output tapes.

- A utility program was written to remove duplicate entries in the seismicity files.

- MBSFIX, a program which adjusts the magnitude field of SEISFILE format tapes, was written, tested, and catalogued.

- A program was written to allow modifications to the MBS field in SEISFILE tapes.

- The SEISFILE data edit program MBDFIX was modified to suppress printout of the records changed and to change all records to type "v".

- Modifications were made to the TS44 FTP subsystems to allow Remote Job Entry from the SDAC-UNIX.

- The Flinn Region and Geographic files were moved from the NEP System to the TS44 System. A Fortran access package to read the files was coded and tested.

- The Flinn Grid files and access program were dumped to tape and moved to the VAX-11/780 system.

- The DOS program FINDEM was modified to run under TS44.

- Program QCREP, which processes NEWQC summary tapes, was completed.

- The spectral analysis program FORYAY was converted to run under TS/PS.

- A program to read ISC tape format and extract selected fields was written.

- Programs to subset and to quality control the SDCS tapes were written. The SDCS subsetting program was also modified so that it can demultiplex up to 18,000 data points per channel.

- Program ILPA was modified to handle all 21 channels from the array.

- Station names in program which SURVEY is used to list SP detections were updated.

- Programs DPBEAM and NSSBEAM which form beams from LASA and the NSS site respectively,were analyzed in an effort to combine their features into one program.

- A new interpolation routine was written to support the digitizer.

- Program NSSBEAM was modified to validate the channel offsets requested on parameter cards.

- A program named LGSUB was written which creates a four-hour data tape for the detection experiment.

The following programs were catalogued during the contract period:

AWRECAT- received from Atomic Weapons Research to generate special graphs,
DIGKRNCH- digitizer software for the TS system,
ILPA- used to SUBSET ILPA field tapes,
KINSUB- used to SUBSET the KINEMETRICS A/D tapes,
MBDFIX- allows the adjustment of MBD fields in SEISFILE tapes,
NEWPLOT- used to plot SUBSET tapes on the 360/44,
NSSBEAM- used to SUBSET, PLOT, and BEAM the stations on

PARSER- process seismic data in support of the SDAC Disaster Preparedness Plan,
PLIST- provides a formatted listing of the card image tape created by the program PARSER,
QCREP- process the NEWQC SUMMARY TAPES,
SIZE- used to monitor how much space is consumed by users on the TS44 System, and
SURVEY- lists the short period detections on a SRO tape.

The following programs were deleted in December 2979 from the online system during the contract period but are retained on backup tapes:

ADDMAC- adds macros to Macro Lib,
FORMAT- text formatter - document preparation,
FORTFLW- flowcharting program,
FORTX- phase of WATFIV compiler,
LETTERS- banner Program,
MULTISPY- finds number of files on a multi-file tape,
M7AF- replaced by M7AY - processes various source tapes containing seismic data,
OLDQC- replaced by NEWQC - the DPS quality check program,
PEBCDIC- print translator EBCDIC from ARPANET,
PLTTPS- replaced by NEWPLOT - plots subset tapes,

| | |
|---|---|
| QEST- | a phase of the program QUERY modified and recatalogued, |
| SENDT010- | tape transfer to PDP10 computer via ARPANET, |
| SNDVNET- | an old version of PAFB block transfer program, |
| SROARIV- | prints SRO detections from an SRO tape, |
| TILPEDIT- | a Texas Instruments program to edit LP data, |
| USERTAPE- | tape library maintenance program, |
| WATFIV- | student Fortran compiler, and |
| YATF- | program to read South African data from a harris tape. |

## MAINTENANCE (Task 4.3)

The computer systems and the equipment to support the data libraries are maintained by Geotech personnel and other suppliers under contract to Geotech. During this contract period, Geotech personnel maintained the Communication Control Processor (CCP), timing systems, modems, and ARPANET interfaces associated with the real-time data collection and monitoring systems. The NEP graphics system was also maintained by Geotech personnel. The NEP graphics system is composed of a DEC PDP-11/35 computer, an Evans and Sutherland Picture System, Vector graphics device, a printing terminal, an Ann Arbor alphanumeric terminal, two Pertec Disk Drives, and aan interface to the IBM 360/40. Other computer systems and/or peripherals maintained by Geotech include some of the peripherals on the DEC PDP-11/70. The major units are: four Kennedy tape drives and controller, a Pertec disk, 192K words of core memory, a Versatec printer plotter and its interface, and a Calcomp plotter. At the end of the contract period, a DEC PDP-11/40 was obtained and configured to be an A/D system. The computer, the A/D converter card, the RP04 disk drive, and the Kennedy tape drive configured with it are also maintained by Geotech. Analog filters, analog tape drives, test equipment, A/D conversion components in the analog laboratory, the tape evaluator, numerous film viewers, anad reproduction equipment used throughout the laboratory are also maintained by Geotech. Some minimal maintenance was performed on the PDP-15/50 prior to declaring it in excess.

Contract maintenance was obtained from the suppliers of the equipment as shown below:

| Supplier | Equipment |
|---|---|
| IBM | Two 360/40's the 360/44, and unit record equipment |
| FABRITEC | 360/40B Memory |
| DEC | PDP-11/70 |
| MEMOREX | Disk drives (5 on the 360/40B) |
| CALCOMP | Disk drives (5 on the 360/44) |
| CDI | Five 1030 Teleterm terminals |
| WILLIARD | Air-Conditioners |
| SYSTEM INDUSTRIES | Two 300 M Byte Disk drives and one controller |
| MISC | After hours maintenance, typewriters, and calibrations to test equipment. |

In May of the contract period a DEC VAX 11/780 was delivered. This system remained under warranty for the remainder of the contract period; consequently, no maintenance contracts were necessary. In summary, the distribution of maintenance costs were: Geotech 52.3%, IBM 32.0%, and all other 15.7%.

The time spent on the various systems by SDAC maintenance personnel is summarized in Table VIII. The hours noted do not include the time spent for duties such as ordering parts, designing components for special systems, planning for future systems, and obtaining budgeting information for proposals or system alternatives. The time shown is for actual repair or maintenance to the indicated system and could also be an estimate of the downtime for the system itself.

The following sections in this chapter give specific details concerning the repairs of the systems maintained by SDAC maintenance personnel.

CCP

An intermittent data transfer problem in the CCP memory was corrected, and a Silent 700 terminal was repaired.

A defective BSLI card in the CCP was repaired. The off-line maintenance system was completed and used to diagnose several bad cards in the inventory.

The CCP update installation was completed in August. The following maintenance problems were encountered and corrected during the installation:

- Twenty-six cooling fans were replaced,
- three defective bus coupler cables were replaced,
- two new BCP cards had defective solder connections,
- one new BCP card had a defective memory register,
- four new BCM cards had defective solder connections,
- one new memory module had addressing problems,
- a power supply became unstable and was replaced, and
- the power switch and the punch motor brake unit on the Remex paper tape unit were replaced.

NEP Graphics Station

A power supply on the PDP-11/35 was repaired.

Repairs were made on the E&S system line generator output card to correct a problem associated with the refresh buffer node bit in the picture processor status register.

## Table VIII. - SDAC Maintenance Distribution in Hours

| | OCT | | NOV | | DEC | | JAN | | FEB | | MAR | | APR | | MAY | | JUN | | JUL | | AUG | | SEP | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR | PM | RPR |
| CCP | 2.0 | 2.0 | 2.0 | 0.5 | 2.0 | - | 2.0 | 3.0 | 2.0 | 15.0 | 2.0 | - | 2.0 | - | 2.0 | 4.0 | 2.0 | 6.0 | 2.0 | - | 2.0 | 50.0 | 2.0 | 4.0 | 24.0 | 84.5 |
| Analyst Station | 8.0 | 12.0 | 8.0 | 5.0 | 4.0 | 8.0 | 8.0 | 6.0 | 4.0 | 9.0 | 4.0 | 10.0 | 4.0 | - | 16.0 | - | 16.0 | 21.0 | 16.0 | 6.0 | 16.0 | - | 16.0 | 9.0 | 120.0 | 86.0 |
| DEC 11/70 | 2.0 | - | 2.0 | - | - | 3.0 | - | 8.0 | 2.0 | - | - | 2.0 | - | 6.0 | 2.0 | - | - | 6.0 | - | 2.0 | - | - | - | - | 8.0 | 27.0 |
| A/D and Analog | 8.0 | 16.0 | 8.0 | 1.5 | 8.0 | 20.0 | 8.0 | 4.0 | 8.0 | - | 8.0 | 4.0 | 8.0 | 29.0 | 4.0 | 24.0 | 4.0 | 3.0 | 4.0 | 10.0 | 4.0 | 15.0 | 4.0 | 15.0 | 76.0 | 144.5 |
| Plotters | 2.0 | - | 2.0 | 4.0 | 4.0 | 3.0 | 4.0 | - | 8.0 | - | 8.0 | - | 8.0 | - | 8.0 | - | 4.0 | 5.0 | 4.0 | 5.0 | 4.0 | - | 4.0 | - | 60.0 | 17.0 |
| Terminals | - | - | - | 2.0 | 2.0 | 4.0 | 2.0 | 5.0 | 2.0 | 7.0 | 2.0 | 1.5 | 2.0 | 7.0 | - | 8.0 | - | - | - | 6.0 | - | 7.0 | - | 4.0 | 10.0 | 51.5 |
| Miscellaneous | - | 40.0 | - | 32.0 | - | 20.0 | 30.0 | - | - | - | - | 44.0 | - | - | - | 73.0 | - | 50.0 | - | 43.0 | - | 12.0 | - | 39.0 | 30.0 | 353.0 |
| Total | 22.0 | 70.0 | 22.0 | 45.0 | 20.0 | 58.0 | 54.0 | 26.0 | 26.0 | 31.0 | 24.0 | 61.5 | 24.0 | 42.0 | 32.0 | 109.0 | 26.0 | 91.0 | 26.0 | 72.0 | 26.0 | 87.0 | 26.0 | 71.0 | 328.0 | 763.5 |

*PM = Preventive Maintenance

RPR = Repair

A defective arithmetic logic card was replaced, a Pertec disk drive was aligned, and a disk control cable was temporarily fixed on the 11/35.

The E&S graphics arithmetic unit was repaired.

A defective module was replaced in the 11/35 memory; a power supply was also repaired.

Twisted pair wiring was installed on the DR11B interface and a cassette tape drive was repaired.

Repairs were made on an analog discriminator.

A hardware evaluation test was performed on the PDP-11/35 to investigate an error reported by the operating system.

A P-4 phosphor CRT was installed in the graphics display for engineering test and evaluation.

PDP-11/70

Maintenance was performed on the RP04 disk drive and the boot loader card in the 11/70. Repairs were made on the Pertec cartridge disk drive and a Kennedy tape drive. System Industries completed the installation of the 300MB disk drive and dual CPU option.

Additional terminal data lines were installed and a switching panel was fabricated to allow the terminals to be connected to the PDP-11/70 or to the VAX-11/780.

Repairs were made to the cartridge disk drive on the PDP-11/70 to correct checksum errors.

An 8K memory bank was repaired.

Head alignment was performed on the two Kennedy tape drive units.

Damaged heads in the RP04 disk were replaced.

Two DZ-11 multiplexors were replaced and a replacement for a backplane was ordered for the 11/70.

System Industries replaced a power supply and reseated connections in the 9400 disk controller.

Repairs were made on a Kennedy 9100 tape drive, and a backplane was installed to accommodate a CDZ-11 8-channel terminal interface card.

A/D and Analog

The analog tape reproduce electronics system was repaired and an A/D verification test tape was created for Data Services.

Maintenance and alignment was performed on the FM tape reproduction electronics system.

Plotters

SDAC maintenance assisted in trouble analysis of the IBM 2701 adapter to interface to the plotter.

Routine repairs were made to both the large and small plotters connected to the 360/44.

Terminals

The TI Silent 700 terminals, seven ADM-3A terminals, and a Tektronix 4014 were repaired. The data line from the 360/44 Video terminals to TIP port 21 modems was also repaired.

The Tektronix 4014 terminals were strapped to terminate the GIN mode with a carriage return.

VAX 11/780

A DR11B high speed parallel interface was installed. A 300 baud dial-in phone line was installed. The RP06 disk and the TE16 tape were reconfigured to share the same Massbus adapter to prepare for the S.I. disk installation. S.I. was unable to install their 300MB disk on the VAX because of a failure in their interface. The GRAPHICUS-80 display was received from Vector Automation. The system has not been accepted because of hardware and software problems.

11/40 A/D Systems

The 11/40 system (GFE) was received. The RP04 disk lacked a cable terminator and the static eliminator is defective. These parts and an air filter are on order. The 11/40 was reconfigured to use a standard height rack and to include a Kennedy tape drive in the same rack. The system has been successfully tested with the exception of the RP04 disk. Four fans were replaced during the checkout.

Miscellaneous

All mechanical work on the CCP mockup was completed. Electrical connections and system checkout was accomplished.

Repairs were made on the model 400 microfilm duplicator.

Installation of a new phone circuit to NORSAR was accomplished by DCA and tested by SDAC maintenance personnel.

## DATA SERVICES (Task 4.4)

Data Services' function is to support scientists doing seismological research. Seismological events, either naturally occurring earthquakes or man made explosions, cannot be repeated. This is due to alteration of the input medium by the event. As a consequence of this, it is better, if possible, to average results from a number of events to support conclusions from a research effort.

Data Services is often of assistance to the researchers in establishing the list of events to be used in a research project. This is accomplished in two ways: first, by searching one or more of the epicenter files and second, by relating the file search output to available data sources.

When data selection is completed, Data Services uses a variety of digital programs and analog/digital conversion to assemble the data in a common format, often on a single digital tape. The variety and complexity of original formats recorded makes this a real advantage to the user. This format, SDAC SUBSET, is demultiplexed (each seismic channel being a logical record) and data values are IBM floating point numbers. There are currently some 70,000 seismograms in this format in the SDAC library. It is often possible to satisfy a user's request by copying one or more of the digital tapes containing these seismograms. During the assembly process, Data Services uses a variety of quality control procedures in order to be certain that the data tapes contain the data described.

The principal users of Data Services are the VELA Seismological Center, Teledyne Geotech Research, and the Air Force Technical Application Center. In addition, data was supplied to ARPA Contractors, Universities, and Seismological Research Institutions listed in Table IX. A procedure has been established such that each request to Data Services receives VSC approval.

Table IX. - Data Recipients

Atomic Weapons Research Establishment, Blacknest, U.K.
Cambridge University
Carnegie Institute of Washington
ENSCO, Inc.
Geophysical Institute, Prague
Lincoln Laboratory
NORSAR
Pennsylvania State University
Rome Air Development Center
St. Louis University
Scripps Institute, University of California, San Diego
Sierra Geophysics
Systems, Science and Software, Inc.
Teledyne Geotech, Garland
Tennessee Valley Authority
TRW, Inc. - Ground Space Systems
University of Cambridge
University of Southern California
University of California, San Diego
U.S. Geological Survey, Albuquerque
U.S. Geological Survey, Denver
Woodward-Clyde Associates

Data Service Functions

The things that Data Services does may be summarized as follows:

a) maintains records of content of all seismic data sources available at SDAC,

b) maintains records of system response information, configuration, instrumentation, and operational dates of all data sources,

c) monitors the analog/digital conversion procedures,

d) analyzes and writes specifications for programs to read new digital tape formats or changes in format resulting from site reconfiguration,

e) maintains and searches the seismicity files for events that conform to selected criteria, and

f) responds to a variety of data requests, some of which can be accomplished overnight and some that require months to complete.

Data Libraries

Extensive libraries containing seismic data recorded on digital and analog tape and on film are archived at the SDAC. About one fifth of the available floor space of the facility is used to house these libraries. Maintaining the integrity of these data sources requires continuous effort. Currently, the library is increasing at the rate of about fifteen digital tapes per day.

The digital library contains about 50,000 tapes. The data are from seismic observatories, arrays, and single instrument sites. The princi-

pal sources are LASA, NORSAR, ILPA, ALPA, KSRS, and SRO/ASRO. The on-line data is from Alaska, Pinedale, Albuquerque, NORSAR, and, for a short time, the prototype NSS station at Cumberland Plateau Tennessee. Other archived digital data are from the Special Data Collection System (SDCS), analog to digital conversions for many events, and data recorded at LASA Data Center in Billings, Montana.

The analog tape library contains data from the Long Range Seismic Measurement program recorded between 1961 and 1971 at some three hundred different sites, and data from the five seismological observatories WMO, CPO, UBO, TFO, and BMO. The film library originated with simultaneous recording on tape and film during the LRSM program and the five seismological observatories. It is often used by visiting scientists, as well as our staff for many scientific investigations. A detailed list and count of the tape and film library is given in Table X.

Table X. - Inventory of Magnetic Tape Library

Digital Archive Tapes

| | |
|---|---|
| A/D CNVT | 143 |
| A/D Conversions (LRSM and SDCS) | 1136 |
| AI Data Set | 172 |
| Alaska Station Processor | 1347 |
| CDC 1604 Operations | 501 |
| D/D Conversions (LASA) | 894 |
| Detection Log (ISM) | 31 |
| DOS (System Distribution) | 69 |
| ILPA Field | 500 |
| ILPA Merge | 172 |
| Korean Station Processor | 5598 |
| LASA Copy | 91 |
| LASA Data Center Backup | 3387 |
| LASA Event | 563 |
| Library Control | 15 |
| Long Period (LASA, ALPA and NORSAR) | 5643 |
| Long Period Extended (HGLP) | 1250 |
| New DP | 8122 |
| NORSAR Event | 236 |
| SDCS (DC + DS) | 3565 |
| SDCS Event Subset | 32 |
| Short Period Events | 134 |
| Short Period LASA | 6652 |
| Short Period NORSAR | 1233 |
| SRO Field | 8 |
| SRO/ASRO Day | 3235 |
| TFO Long Period (BGR) | 3 |
| UBO Long Period | 33 |
| SUBTOTAL | 44605 |

Digital Tapes (to be recycled)

| | |
|---|---|
| DPS Development | 64 |
| EP-DP (Pack Backups) | 267 |
| Individual Users | 2252 |
| Mass Store Create | 104 |
| NEP Operation System Backups | 197 |
| Scratch | 1665 |
| UNIX System Backups | 454 |
| VAX System Backups | 9 |
| SUBTOTAL | 5012 |

Analog Tapes

| | |
|---|---|
| British Arrays | 180 |
| Composite | 509 |
| LRSM and Observatory (Compressed) | 10080 |
| LRSM and Observatory | 27021 |
| NTS Strain Test | 108 |
| Queen Creek Strain Test | 324 |
| SUBTOTAL | 38222 |

## Data Recovery Procedures

The maintenance of these libraries and the data extraction, particularly from the digital library, is reasonably complex. Associated with the analog and film libraries are files of station logs. These logs contain the operational details of the site necessary to make the data useful. The information concerns local site conditions which may contribute to ambient seismic noise, local geology, gain values, calibration information, and time corrections to the recorded data. These records are trivial compared to the complexity of recovering data from the digital library. The digital tapes have nearly a hundred variations in format caused by different stations, station reconfiguration, hardware or system changes, and changes in software or transmission protocols anywhere along the data path.

Data requests come from a variety of sources and are satisfied by providing data in several forms. The most common request is for digital data recorded for events in a particular geographical area. Other requests are for copies of SRO/ASRO/DWWSSN data recorded on "day tapes". These tapes result from copying 26 hours (0 hrs. to 02 hrs. on the following day) from digital tapes recorded at all of the SRO sites onto a single tape.

Requests for digitally converting data from the analog library are carefully checked against lists indicating what data have already been digitized to avoid duplication. When digitizing is necessary the output is compared to film recording to assure that no errors have been introduced during the digitizing process.

Paper or film reproductions of the data in the film library can be made and sent to requestors; however, it is not uncommon to find a visiting researcher using the film viewing facilities, and obtaining support from the full-time data librarian.

Data Sets

A significant amount of the work-load of Data Services during the past several years has been to assemble fairly large sets of data satisfying certain parameters. These are referred to as Data Sets. During the contract year, two such Data Sets were assembled.

One of these contained data from the SRO/ASRO sites in Europe and Asia for about 200 events. The second contained all detection intervals from the SRO/ASRO sites for the time period 1-21 April 1979.

Limiting the term 'Data Set' to the above described tasks is somewhat a misnomer. Nearly all requests are for a group of events satisfying a set of parameters. The term 'Data Set' has been arbitrarily reserved for relatively large sets of events.

Conversion of data from analog to digital form continued during the year. The conversions were done using both the PDP-15 and the Kinemetrics system (which was used after June 1980). During the year, there were about 1500 A/D conversions made, with a rejection rate of about 20%. Rejected conversions were remade. These rejections are generally caused by operator error, requestor error, and equipment or software error.

## Seismicity File Maintenance

Information concerning seismic event epicenters and station arrival times is received in a variety of formats. The principal information sources are the International Seismological Center (ISC), the National Earthquake Information Service (NEIS), and AFTAC. Other sources are, in most cases, local networks from which a regional bulletin is produced. These sources usually contain lower magnitude events and are of value for some research projects.

Currently, epicenter and arrival time information is maintained on digital tape for ISC, NEIS, AFTAC, Hagfors, and the French network. These are updated as new information becomes available. Tape files for LASA from 1969 to 1975 and NORSAR epicenter files are also maintained.

Printed seismicity information is kept in a separate room, where it is available to users.

## DATA MANAGEMENT (Task4.5)

There were four major hardware and software systems developed during the contract period. The first was the development and improvement of the Automatic Association program, which was supplemented with a report about the current status of all of the program systems which perform similar processing. The second was a system to perform automatic signal detections which involved two separate tasks; the first task was to obtain a hardware system to perform the detections and the second was to move the detection function from the 360/40A to a system which would facilitate program changes and be easier to maintain. A system to conduct research on locating events at regional distances was also obtained. Although no location algorithms were implemented, special hardware was procured and configured to the same system used for developing the detection algorithms. The last system consisted of special hardware to use as a front end to the CCP that would accept the real-time data stream and perform some of the functions ordinarily accomplished by the CCP.

The details of the development and status for each of these systems is given in the remainder of this chapter.

### Automatic Association (Task 4.5.2)

This task consisted of two very distinct elements. The first was to conduct a study of the operation and processing techniques of other systems performing the automatic association process. The results of the study were reported by J. Goncz in TR-80-2 entitled Present Status and Dynamic Planning for Automatic Association Programs; the abstract of this report follows:

This survey reveals that the five functioning automatic association programs existing today in the world, even though they were developed separately in independent institutions, all operate according to the same general scheme. Different algorithms and strategies do appear in the event refinement process, and seem to use as much of the attributes of the data as possible to exclude misassociations and false alarms. Recommendations are made for the SDAC AA and ADAPS to use as many of these algorithms as can be supported by the data.

Based on this report, several enhancements to the SDAC AA were recommended and implemented into the system. The improvements primarily affect the accuracy of the results but also aid in future development of the system. The AA development included:

a) the installation of a COMBO function to generate trial epicenters from the NEIS arrivals or any other data sources which are not beamed,

b) adding the capability to AA to use a flag in the PAQ generated by the DPS when the spectrum of the signal indicates that it is from a regional event,

c) adding the TRIX algorithms to AA in place of QFIX; this algorithm will provide COMBO with trial epicenters and permit the calculation of local epicenters, and

d) moving the AA process to the VAX 11/780 in order to facilitate future development, decrease processing time, and maintain compatibility with the development of other systems by way of using standard routines and data bases.

## Detection Processing (Task 4.5.3)

Two very different tasks were identified for the seismic detection effort. One involved the study and procurement of suitable computer equipment to do detection experiments and support other research efforts while the other involved implementing a detector for the on-line data stream in a system other than the IBM 360/40A.

### Detection Processing System

This task resulted in the acquisition and installation of a DEC VAX 11/780 computing system. Initially, a DEC PDP 11/70 was considered as a suitable computer for this work and, in fact, the current detector was installed on this computer, as noted in the next section. An evaluation of available equipment indicating that although the 11/70 computer is a good computer for program development it was not recommended for use in DP/Regional analysis experiments. The 11/70 is deficient in I/O bandwidth and program address space. It was also questionable whether the UNIX operating system could support the demands of a high performance graphics terminal. A survey and analysis of existing equipment concluded with recommendations for a System Engineering Laboratory 32/77 computer system to do the tasks, or alternatively, an IBM 4341. To coordinate effort and obtain compatibility in similar research with Lincoln Laboratories, the third recommended computer, a VAX 11/780, was obtained. Primarily to support the detection experiments, the VAX was configured with a CSPI array processor, and special purpose graphics equipment was added to support the Regional Event Location System (RELS) effort.

The installation and checkout of the equipment did not take place until the latter half of the contract period and some of the special peripherals were scheduled for delivery during 1981. A diagram showing the hardware configuration is provided in Figure 5.

Although no hardware was available for system development, some preliminary work was done on the structure of the program system to accomplish the detection experiment. The features of this design and overall system structure encompass the following considerations:

a) an executive is required to execute subordinate modules and sequence processes,

b) I/O routines for both tape and disk should be standardized and shared by all processes,

c) tasks should be monitored to control or limit excessive run times or perhaps prevent program loops,

d) standard programs can be developed to accomplish certain routine processes such as removing the trend or mean, from time series data, filtering, FFT, etc., and

e) isolate detection processes completely within a program module whenever possible to facilitate additional development.

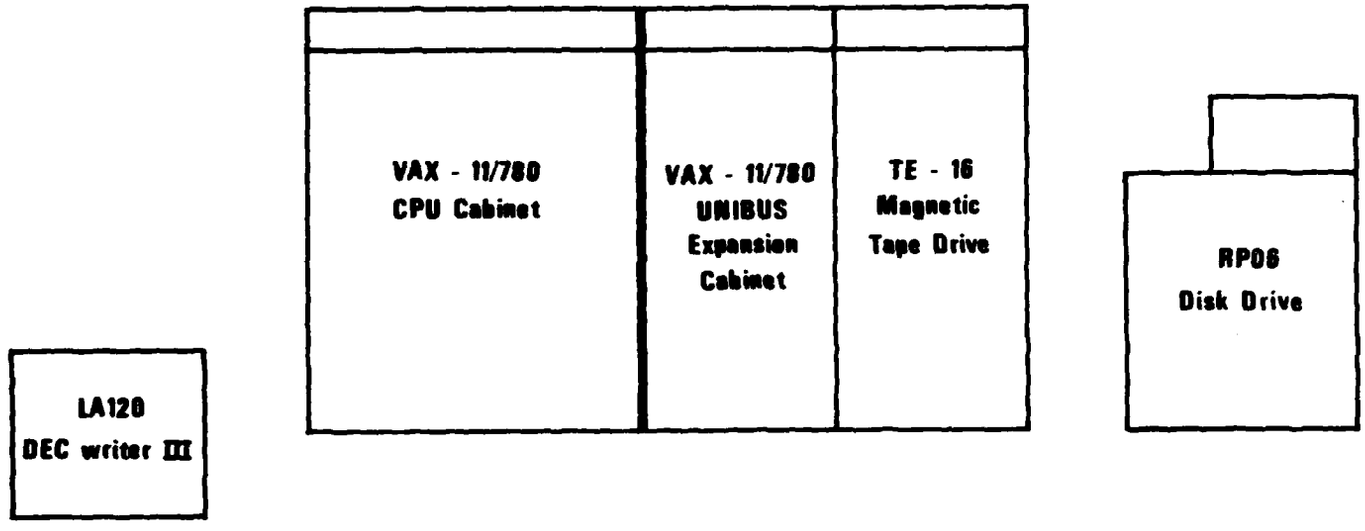


Figure 5. - VAX 11/780 Block Diagram

## Detection Experiment

The on-line real-time detector running on the IBM 360/40A for many years originated during the implementation of the Large Aperture Seismic Array (LASA) and was modified through the years to accommodate a much different data source. Beamforming, which the 360/40A did to the LASA data, was one of the major processes of the computer. Indeed, it even had a special micro-coded instruction set to accomplish this and other algorithms associated with the LASA data. When LASA was terminated, other sites, not from an array but from a widely distributed network, replaced it and were used instead to determine event locations. The complexity of the micro code, beamforming, filtering, and particularly scaling, associated with the detection process remained within the assembly language coded DPS. During this evolution of the software, an error was introduced in the program which resulted in true signals not being detected and a significant number of detections being declared from seismic noise.

Exhaustive investigation to determine the cause of the error yielded nothing. In conjunction with this effort, an off-line detector was developed to run originally on the IBM 360/44. The 360/44 detector was written to verify the algorithms and to optimize parameter values for the detection process; moreover, it was written in FORTRAN and all LASA type processes of special filtering, scaling, and beamforming were omitted, thus resulting in a much simpler program.

The DEC PDP-11/70 was chosen as the target machine for this application. Its very effective editors and program development tools provide a environment in which to develop and test program systems quickly.

The DP algorithm on the 360/44 used as input a single channel of segmented data. The detector on the 11/70 needed to input the real-time data stream of continuous waveforms and multiple channels, and process the many other on-line channels, as well as the NORSAR detections. These extensive programming requirements were much better met on the PDP 11/70 with the development facilities provided by UNIX.

In order to continue research and evaluation of the on-line data, the detection results from the PDP 11/70 needed to be input into the NEP system where they could be compared to the waveforms and where waveforms could be quickly inspected without reference to the detections. The interface from the 11/70 to the NEP system is by way of magnetic tape containing detection data compatibly formatted to the DELOG program for the NEP system.

Dramatic results were obtained from the accurate detectors. The analysis time from the on-line data dropped sharply and more accurate and complete event lists were produced both by the analyst and the automatic association process.

Regional Event Locataion System (Task 4.5.4)

Most of the effort expended in the development of the Regional Event Location System (RELS) was limited to preliminary planning. A thorough review of existing graphic display systems was conducted to determine the system most suitable for this application.

Alphanumeric display devices were also evaluated with the intent to configure a multi-display analyst station with the VAX as the main processor.

The results of these investigations determined that the most effective graphics display device was a system developed by Vector Automation called the GRAPHICUS 80. The unique attributes of this system include up to 50,000 short vectors of 0.1 inch per refresh cycle and a display screen width of 16 inches. The high number of short vectors is well suited to the seismic application because a seismogram is highly irregular in shape and can be better represented by numerous short lines.

Two color alphanumeric terminals were configured with the graphics terminal of the analyst station. The devices are manufactured by the Intelligent Systems Corporation (ISC). They have a viewing area of 15 inches wide and 12 inches high. Each line can have a maximum of 80 characters and 48 lines can be placed on the screen at one time. Eight colors are available for both character and backgrounding for a total of 8x8 = 64 - 8 = 56 useful combinations (the minus eight results from white on white, blue on blue, etc.). Color graphics were selected because they were less expensive than large area black and white CRT's and because more information can be displayed in the same area by using different colors to depict data fields rather than using spaces.

All of the equipment, except the hardcopy device for the graphics system, was received and installed during the contract period; however, none of the RELS application programs were developed and only diagnostic and demonstration programs were available at the conclusion of the contract. A picture of the components of the graphics portion of the system was shown in Figure 2.

Numerous meetings and discussions resulted in preliminary plans of the seismic functions to incorporate into the RELS system. Design criteria and specifications were begun and documentation requirements were established. The preliminary work of establishing documentation procedures and development procedures was accomplished by the end of the contract but little progress was made in implementing the RELS application code. Further progress was impeded because of the questions regarding the recommended system and the late delivery of the hardware.

Intelligent Line Interface (Task 4.5.5)

Intelligent Line Interface (ILI's) were implemented in the real time data stream to decrease the processing done in the CCP. The concept is to build front end processors to the CCP that will uniformly structure the data before they are input. The data from the Pinedale Wyoming site were routed through an ILI. The conversion of the data consisted of formatting it into the VELA communications protocol and converting the 12 bit data samples to a 16 bit computer word format.

The structure of the ILI to do this processing established a system having a general framework to add detectors, maintain error statistics, and implement line control protocols for each communication path.

## SYSTEM IMPROVEMENTS

Several changes were made to the operational systems during the contract period. These changes either added capabilities or improved existing methods of processing by increasing throughput or changing operational procedures. The X-Y digitizer was moved from the 360/44 to the DEC PDP 11/70, the bus structure on the CCP was upgraded to allow full redundancy between the processor, memory, and I/O busses, a communication link was established to the USGS in Colorado, and a system was obtained to do the analog to digital conversions.

### X-Y Digitizer (Task 4.6.2)

The operation of the X-Y digitizer was moved from the IBM 360/44 to the DEC PDP 11/70. The DEC 11/70 provides both hardware and software that can support this activity. There are storage type CRT's, Tektronix, on the 11/70 which can be used to view the output from the digitizing process. A general purpose graphics support package also exists on the 11/70 that is used to examine the waveforms on the Tektronix and output the waveforms to magnetic tape in SUBSET format.

### CCP Upgrade (Task 4.7)

The bus structure of the CCP was improved to allow full redundancy and back-up in the event of component failure. An additional bus was added to the system that will permit DMA transfers between all major components. This improvement will reduce downtime by making it possible to perform corrective maintenance without turning off the system and permit the system to operate during the failure of major components.

## Data Translation Hardware (Task 4.8)

A small system was developed to transmit data to the USGS in Colorado. The system is connected to the CCP which sends it the NORSAR data stream and timing information. It then buffers these data, to insure a continuous output, then converts the digital data to analog and outputs the analog data to a dedicated phone circuit. The output consists of one channel of short period data and one channel of long period data selected from the three NORSAR SP and 19 LP available data channels.

## A/D Conversion System Update (Task 4.9)

Analog to digital conversions have been done by several different systems over the years. The previous contract included a task to develop an A/D system using equipment borrowed from the Special Data Collection System Project. This system had certain operational aspects which make errors easy to introduce and make little information concerning records about the operation. In addition, an extra computer run was required for each conversion to obtain compatibility between the A/D system and other computer systems.

A DEC PDP 11/40 system was used at the Mass Store to buffer seismic data during the time we were transmitting data there. When this transmission was terminated the DEC 11/40 system was moved to the SDAC with the intent to develop the A/D operation on it. The configuration of this system is shown in Figure 6.

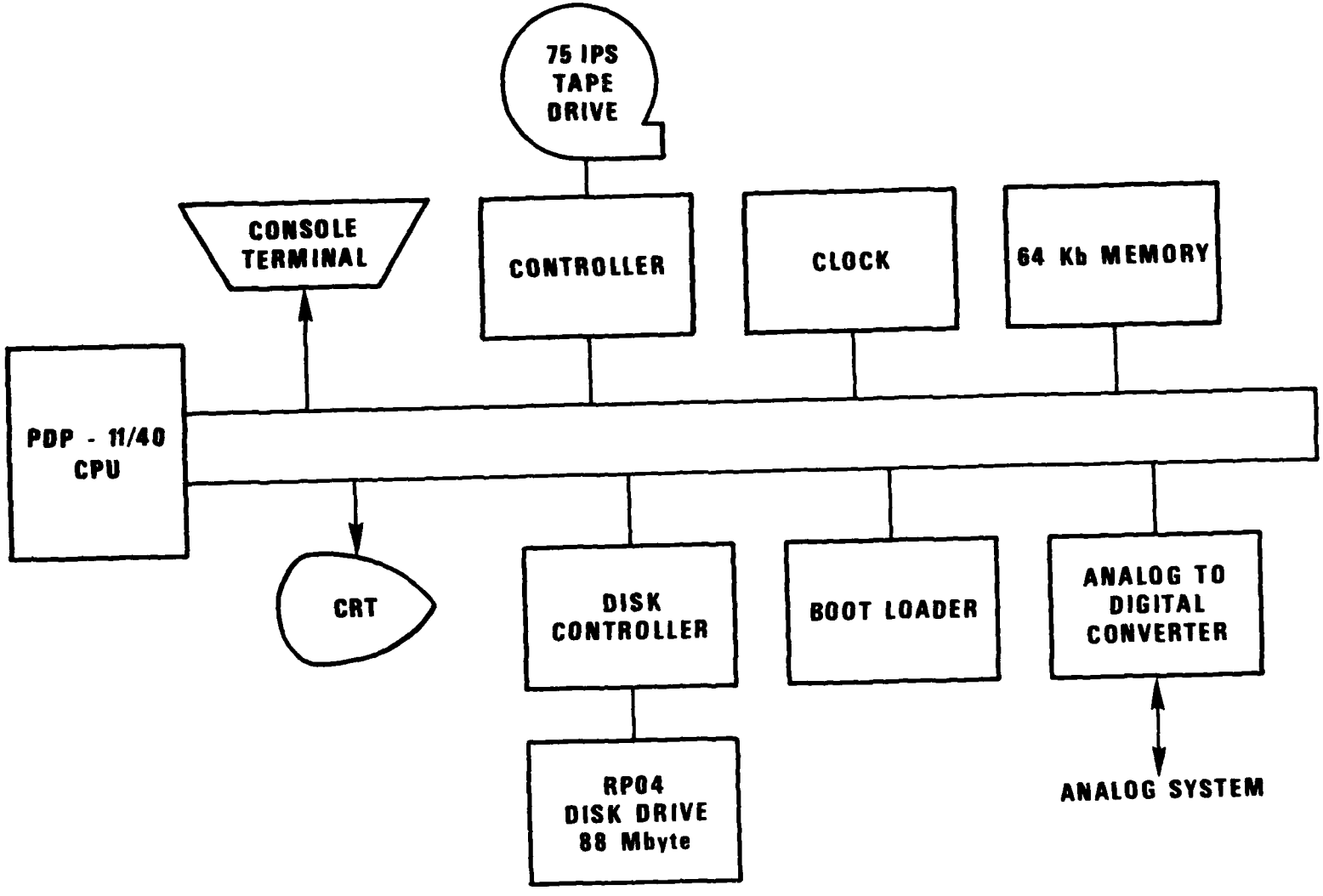


Figure 6. - A/D Conversion System Block Diagram

Because this is a general purpose computer system, the A/D operation is done under program control, thus providing greater flexibility and ease of use. Operator logs are automatically produced and provide a summary of system activity for QC purposes.

## REPORTS AND DOCUMENTATION

Many of the documents delivered for the contract were updates to existing manuals and notebooks. These updated documents include the:

SDAC Operations Manual
SDAC Maintenance Plan
Communication Control Processor Workbook
Prototype Regional Seismic Station Interface Workbook
Detection Processing System Workbook
Network Event Processor Workbook
SDAC Network Event Processor Analyst's Guide

The documentation for the development of the data management systems included the following:

Preliminary Design Plans
Design and Implementation Plans
Acceptance Test Procedures
Acceptance Test Results

In addition, the following reports and documentation were written:

Intelligent Line Interface Workbook and Updates
Seismic Data Processing System Workbook and Update
Technical Report TR-80-2 - Present Status and Dynamic Planning for Automatic Association Programs
Computer Program Documentation for New Programs
A/D Equipment
Data Translation Equipment


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